reflectors with $n\lambda$ spacing; $45°-\theta/2$ reflectors with $n\lambda/(1-\sin(\theta))$ spacing; and $45°+\theta/2$ reflectors with $n\lambda/(1+\sin(\theta))$ spacing. Also, in this case, the reflective boundary may be formed of a set of concentric rings with a surface spacing of $\lambda/2$.

[0486] There are many substrate options: glass, aluminum, enamel-on-aluminum Love-wave substrate, etc. The choice of acoustic mode and substrate do not affect the sensor geometry except in determining the maximum size. For example 5.53 MHz Rayleigh waves on aluminum can support sizes with a diagonal dimension larger than 30 centimeters.

[0487] In a particular embodiment, a hemispheric aluminum dome is provided approximately 300 mm in diameter. Near the "equatorial" concave opening, a pair of reflective arrays are provided on the outer surface, each extending almost halfway around the hemisphere and nearly meeting at each side. On each end of each reflective array is provided an ultrasonic transducer, such as a piezoelectric ceramic element, which may be mounted on a wedge, to generate or receive an acoustic wave traveling parallel to the axis of the reflective array.

[0488] Near the apex of the dome, another reflective member is provided, having a diameter of approximately 100 mm. This apical reflector may be strongly reflective for perpendicular incident waves and weakly reflective for possible parasitic acoustic paths at other angles of incidence.

[0489] Each reflective array includes three sets of reflective elements:

[0490] 1. 45° to axis of symmetry of hemisphere with spacing of $n\lambda$

[0491] 2. $45°+\theta/2$ (35.5°) to the equatorial plane of the arrays with spacing of $n\lambda/(1-\sin\theta)$

[0492] 3. $45°-\theta/2$ (54.5°) to the equatorial plane of the arrays with spacing of $n\lambda/(1+\sin\theta)$

[0493] Mirror reflection ambiguities in these reflection angles are resolved by considering the desired acoustic paths along with the angle-of-incidence-equals-angle-of-reflectance criteria. θ is the angle between the center of the hemisphere of the upper reflective member, about 26°.

[0494] In this case, portions of a wave transmitted from a first transducer along one of the pair of arrays are emitted along great circles of the hemisphere, which are then received by the other reflective array, following a path parallel to the reflective array to a receiving transducer. Other portions of the wave are directed directly toward the apical reflective member and back down toward the originating reflective array and originating transducer. Therefore, at any time, a wave emitted by one transducer is received by that same transducer as well as one receiving transducer associated with the other array. Therefore, both systems may be operative simultaneously to receive acoustic waves without substantial mutual interference. The transmit transducers **T1** and **T2** may emit acoustic bursts sequentially.

[0495] Alternately, these arrays may be shingled, inclined at a small angle to allow the transducer of one array to sit distal to an end of the other array. Of course, the angles and spacing of the array must be compensated for this inclination per the spacing-vector formula. In a preferred embodiment, the transducers are tucked just below the equator and the corresponding reflector arrays follow great circles that end pass just above the transducers at the opposite side.

[0496] Furthermore, there may be greater than two transducers and arrays, allowing a plurality of sensing waves to be emitted by a transducer and received by a plurality of transducers, according to the principles set forth herein.

[0497] It is noted that, on any substrate, and in particular in substrates which are nonplanar, the coordinate system employed to define the perturbation position need not be in a Cartesian or pseudo-Cartesian system, and therefore may be expressed in a polar coordinates, or in other terms. Further, in certain instances, extrinsic factors, such as an overlay or superimposed image may be used to define valid entries, and therefore the ambiguities in the input position are need not necessarily be fully resolved solely through acoustic wave perturbation analysis in every instance in order to provide a useful output.

Example 14

[0498] FIGS. **21**(*c*) and **21**(*d*) provide another example of a non-planar sensor utilizing the principles of **FIG. 20**. Again we consider a section of a sphere. This time the touch surface corresponds to everything north of the "Tropic of Cancer", and the region between the equator and the Tropic of Cancer is available for arrays and transducers. This system is described in further detail below.

[0499] The dome sensor shown in FIGS. **21**(*c*) and **21**(*d*) is hemispherical in shape. The touch region is above the "Tropic of Cancer" at 23.5° N latitude and is redundantly covered with no dead regions by three pairs of sensor subsystems. Arrays and transducers are placed in the region of the hemisphere between its base or equator and the Tropic of Cancer. The arrangement of transducers and arrays are shown in the flat-map projection given in **FIG. 21**(*c*). One of the six sensor subsystems is illustrated from a top view perspective in **FIG. 21**(*d*).

[0500] In the simplest embodiment with six sensor subsystems, each array arc in **FIG. 21**(*c*) corresponds to a single set of reflective elements forming an array. However, according to the present invention, it is noted that these arrays may be superposed to support additional sensor subsystems, and therefore each transducer may be associated with a plurality of wave paths, providing further redundancy. The simplest embodiment is described in more detail below.

[0501] Equally spaced around the equator are six pairs of transducers, one transmit and one receive. Each transducer pair supports one sensor subsystem. Each of the following three sensor-subsystem pairs fully cover the touch region above the Tropic of Cancer: **R1**/**T1** and **R4**/**T4**; **R2**/**T2** and **R5**/**T5**; and **R3**/**T3** and **R6**/**T6**.

[0502] For clarity of presentation only, **FIG. 21**(*c*) shows a gap between the end of the transmit array for **T1** and the receive array for **R4**, and likewise for other diametrically opposed transmit and receive transducers. In practice, it is desirable to extend both arrays so that there is an overlap. This assures that there is no dead region, and in fact an overlap between, for example, the **R1**/**T1** sensor subsystem and the **R4**/**T4** sensor subsystem. The overlapping portions of the arrays have reflector elements approximately mirror reflected with respect to the array axis.